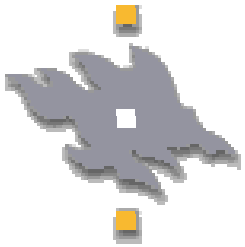
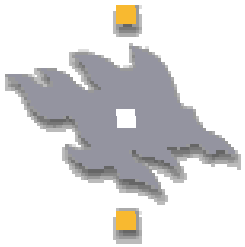


Lecture #14: 18th March 2004

Semantic Web Services

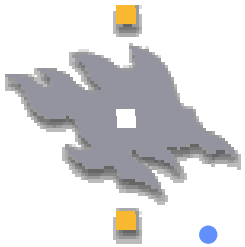
Suresh Chande

Department of Computer Science



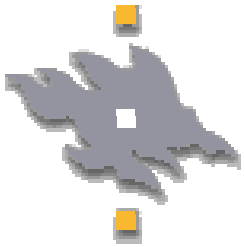
Reminders

- Seminar Article : **Deadline March 25th / Hard March 28th**
- **1 hour seminar/poster presentation on: March 31st / April 1st**



Web as it existed

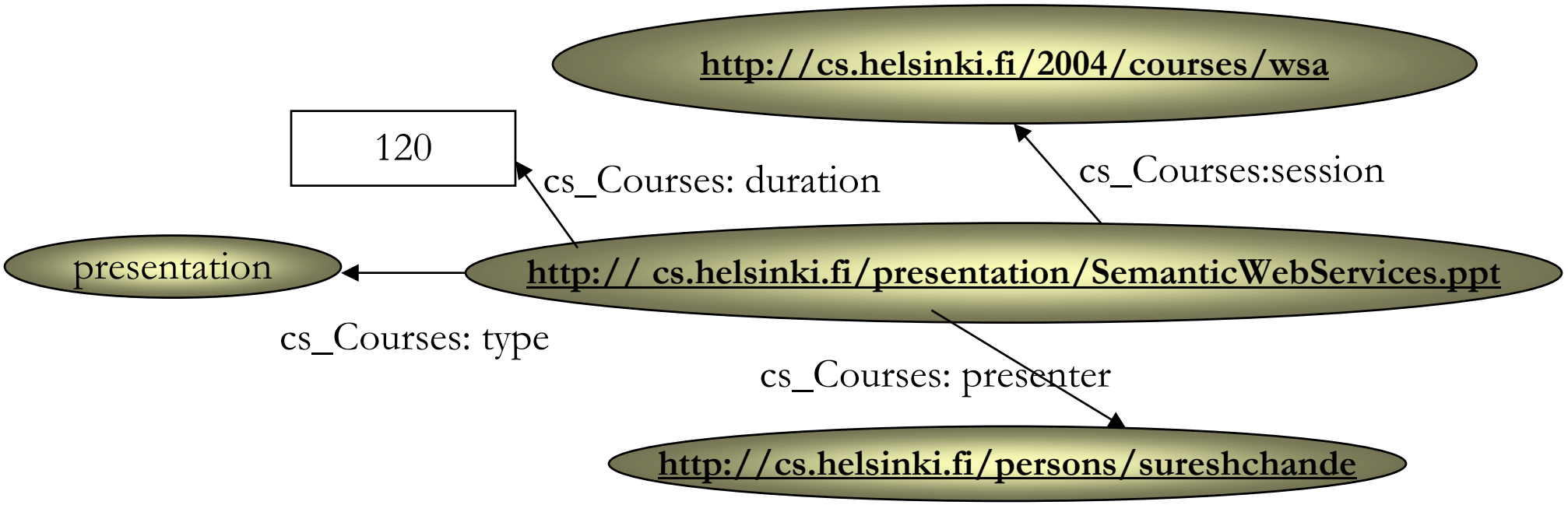
- The Success of the Web is built around links URI/URLs and are at the center of the concept of WWW
- These Links at the same time do not say anything more about a specifically referenced Web Resources, which is interpretable by a human being.
  - **Past:** Web has been used for direct end user consumption
  - **Now & Future:** How can we move towards automation and tool based support to access the Web ?
  - **What's needed:** A well defined terminology to represent the intention, properties of the services and the meaning of certain information available on the web. The terminology should be defined such as to be machine interprettable
- How can Software Agents infer from the Web resources and allow user's to delegate processing over the Web ?



A need for Metadata

- Metadata is information about information, services or resources.
- The meta data once represented in a form that is interprettable, as it is defined based on a well defined terminology, can be utilised by systems/agents to automatically extract the meaning of a service or resource and accordingly make decision on the rightful usage of such resource, service or information
- In the Semantic Web world a well defined Meta data is represented as statements about the resources, services or any information
- Statements can be modeled with:
  - **Resources:** an element, a URI, a literal, ...
  - **Properties:** *directed* relations between *two* resources
  - **Statements:** "triplets" of two resources bound by a property

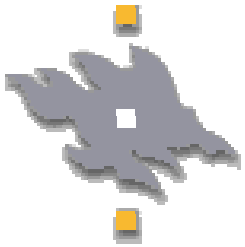
Semantic Web – an Example



- Resource

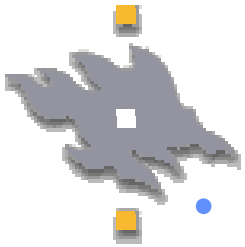
- Property

- Name of the Property



RDF

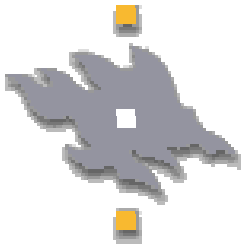
- RDF Stands for Resource Description Framework
- *RDF* is a general model for depicting such statements
- It is a markup language using which metadata(set of statements) about a specific resource can be prepared.
- RDF contains within it the terminologies but does not have means to define the terms and terminology.
- Ontologies defines the terms, the relationship between the term which can be used to depict a particular meaning of a resources and specifically in defining the statements



Semantic Web – In a nutshell

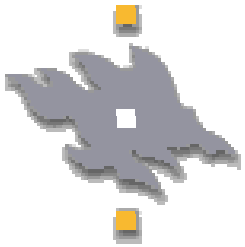
- *The "Semantic Web" is a metadata based infrastructure for reasoning on the Web.*
- Semantic Web utilises: Web Ontology Language(OWL) to define the terminology which could be utilised in preparing statements related to specific resources
- OWL is a revision of the DAML+OIL web ontology language incorporating lessons learned from the design and application of DAML+OIL
- The OWL also posses several other means of defining the constraints, characteristics and equivalence of terminologies across different ontologies
- OWL comes into three levels:
  - OWL Lite : Classification hierarchy and simple constraint features.
  - OWL Description Logics: Maximum expressiveness
  - OWL Full
- Description of Services using -> OWL-S / DAML-S

Reference: A Presentation by Ivan Herman ->**http://www.w3.org/2003/Talks/1112-BeijingSW-IH/5.html**



Semantic Web – In a Nut Shell

- Data Encapsulation Framework **– XML**
- Document Structuring & DataTyping **– XML Schema**
- Description of the Information/resources **- RDF & RDF Schema**
- Terminology definitions **Ontologies.** A Language to define ontologies **- OWL**
- Data types **– OWL types or acceptable XML Schema datatypes**
- Addressing **- URI/URL**
- Messaging & Transportation Framework **-HTTP**
- Security **-HTTPS\SSL\TLS**
- Discovery & Registeries **- UDDI**
- Description of Services **– OWL-S**
  - Discovery & Publishing **- Profiles** (UDDI/public registries)
  - Semantics & How does it work ? **- Model**
  - Binding **- Grounding** (relation to WSDL Messages, Operations & SOAP binding)

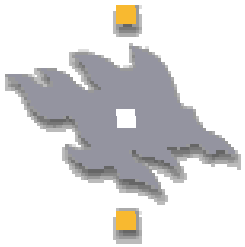


Adaptation / Transformation of Web Services towards Semantic Web principles

- Discovery should all be SW-based.
- WSDL equivalent in RDF -> DAML-S
- RDF as SOAP payload
- RDF Query where XML Query (or XPath) is used.
- SW Business rules engines call out to WS
- Remote RDF Query could use SOAP
- Remote RDF update should use SOAP.

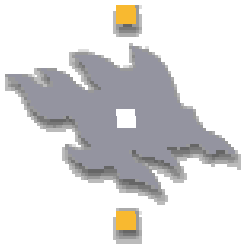
W3C's Semantic Web Services interest Group - Mission Statement -

- To coordinate ongoing research initiatives in the Semantic Web Services area;
- To promote the results of SWSI work to academia and industry.
- Create infrastructure that combines Semantic Web and Web Services technologies to enable maximal automation and dynamism in all aspects of Web service provision and use, including (but not limited to) discovery, selection, composition, negotiation, invocation, monitoring and recovery;
- Begin with defining the basic technologies:
  - Metadata creations and a frameworks XML, RDF, RDF Schema, RDF Query, Reasoning
  - Terminology for defining Metadata: Ontology OWL
  - Application of these technologies to add dynamism into Service description, discovery, invocation,execution & managements(monitoring & control): OWL-S (DAML-S) initial work carried out at http://www.daml.org



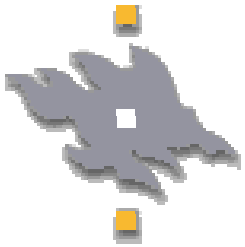
OWL-S (formerly known as DAML-S)

- Services hosted over the Semantic Web should enable users to automatically locate, select, employ, compose and monitor them automatically
- This requires that the useragents be capable to interpret the descriptions exposed by such services inorder to automise the various interaction employed with such services.
- OWL-S provides a framework using which these services can be described and published. The framework provides the ontological structuring mechanisms.



OWL-S (formerly known as DAML-S)

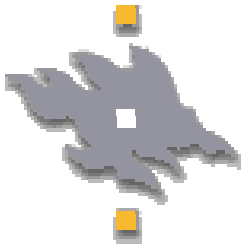
- A core set of markup language constructs for describing the properties and capabilities of their Web services in unambiguous, computer-intepretable form
- OWL-S is an OWL based Web Service ontology
- OWL-S markup of Web services will facilitate the automation of Web service tasks, including automated Web service discovery, invocation and execution monitoring, composition and interoperation.



OWL-S 4 Main Objectives

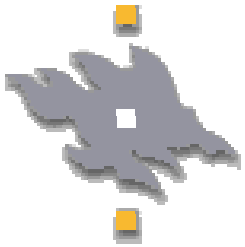
Automization / Dynamism of the following core web service activities :

- Service Discovery
- Service Invocation
- Service Composition & Interaction
- Service execution monitoring



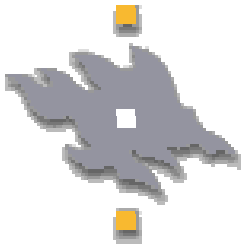
OWL-S Service Discovery

- Definitive service description structures
- Publish on the service's website or service broker hosted registries(UDDI?).
- Descriptions based on specific ontological representations, which will enable :
  - Search features of a registry based on requested constraints.
  - Declarative advertisements of service properties and capabilities, used for automative service discovery



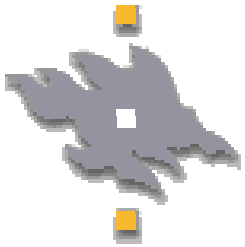
OWL-S Service Invocation

- OWL-S provides a means to publish declarative APIs of a services.
- These APIs are interprettable by a software agent as the description is based on standard and interpretable vocabulary the software agent can understand
- Agent should be able to interpret and automatically handle :
  - Input that should be delivered to a service
  - Establish/Satisfy any preconditions prior to utilising the services
  - The corresponding Output that will be generated
  - How to invoke such an interface automatically



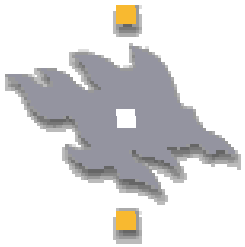
OWL-S Service Composition

- OWL-S enables means to selectively choose the Web Services, forms them into a composition and orderly invoke these services to achieve the goals of the objectives.
- OWL-s enables this by providing through its language constructs to :
  - Selectively choose a webservice
  - Compose such choices
  - Invoke the composition
- This is enabled by declarative specifications providing :
  - Pre-requisites of using a service
  - Consequence of using a service



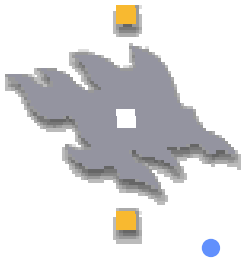
OWL-S Execution Monitoring

- Execution of Services over the Web will eventually require to be monitored for its status and changing states affect the clients accordingly
- This sort of requirements exists in both the cases if a services is a simple one or is madeup of a composition of simpler or other compositions.
- The various requirements of their monitoring are:
  - Current Status
  - Affect the status
  - Cancel the execution of such execution
  - Update the properties of such execution
  - Lifecyle management
- **Note:** This part of the OWL-S has not been specified



OWL-S

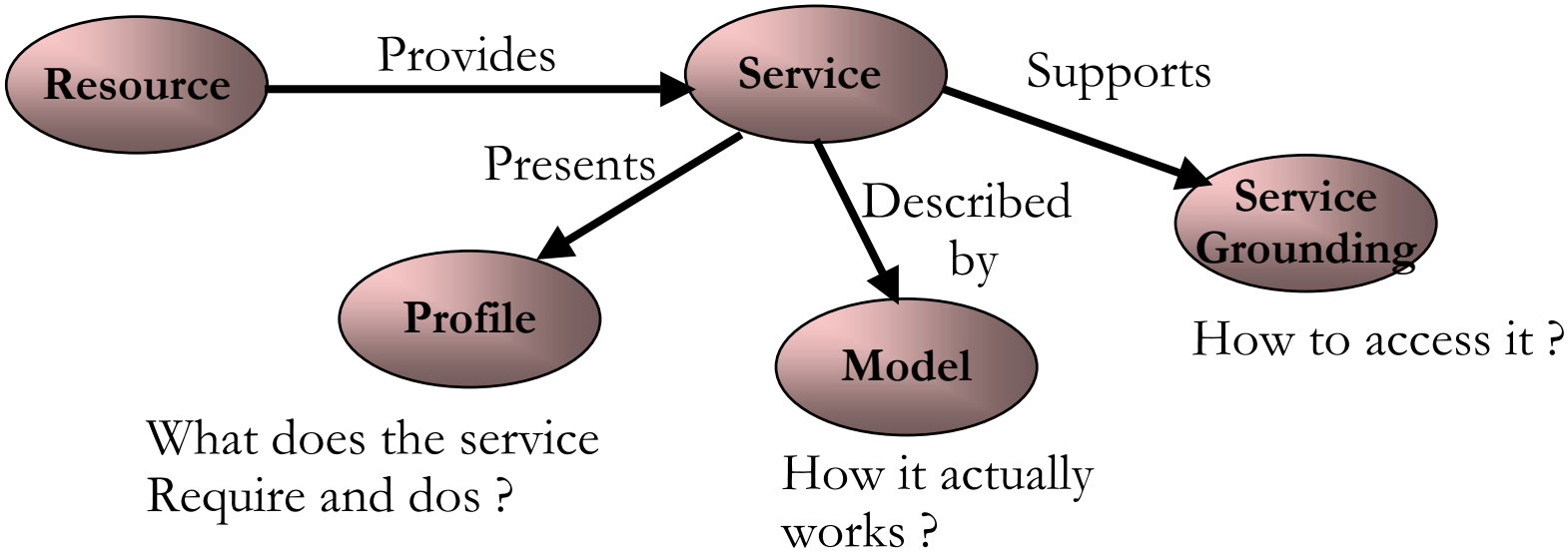
- OWL-S basically consists of three parts
  - **Service Profile:** Advertising & Discovery
  - **Process Model:** Service operation description
  - **Grounding:** Service Interoperation details
- The main scope of OWL-S is to address the needs of Simple Web Services and Complex ones which could be composition of several simpler services(Choreography)



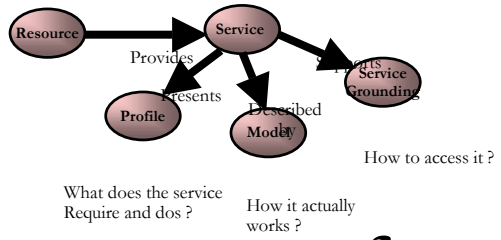
OWL-S

- **Service profile:** For advertising and discovering services;
  - Concisely represent the service in terms of capabilities, features and operational parameters (for e.g. cost-of-use, quality-of-service parameters, etc), for constructing both advertisements and requests.
- **Process Model:** Gives us a detailed description of a service's operation
  - Provides a declarative description of the processing by which a Web service is realized
- **Grounding:** How to interoperate with a service, via messages.

OWL-S Overview

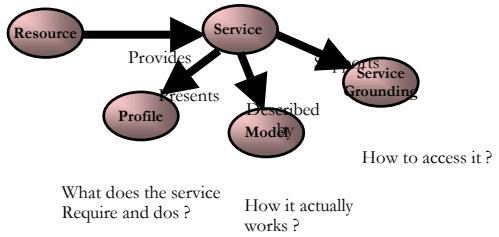


OWL-S Profile



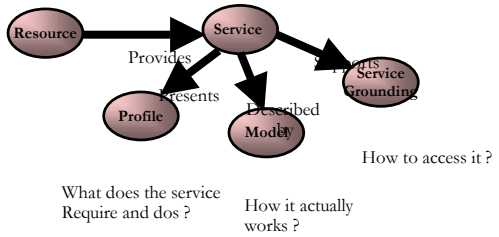
- Provides concise description for the purpose of a registry/discovery.
- Once a Service has been selected Services Model is utilised to carry out further interpretation and the profile if no longer necessary.
- Describes the Services as a function of three different elements of Information :
  - **Provider Information:** Name, Description, Contact Information
  - **Functional Description:** Input/Output, transformation produced by the service and preconditions
  - **Service Features:** QOS, Reliability, time to respond

OWL-S Model



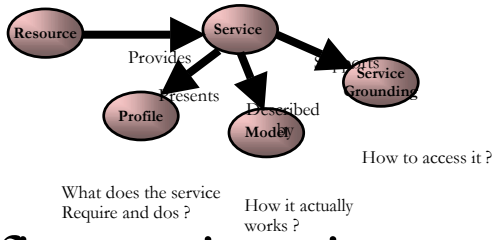
- Depicts the service operational features as a process and how the process functions are represented by:
  - Flow of data: the transformations that occurs
  - Control flow: State transitions that occur in service interactions
- The OWL-S Model can be considered to consists of two main parts :
  - **Process Ontology:** Describes the services in terms of the Input, Output, Pre-conditions and Effects, Subprocesses (planning, composition and service interoperation)
    - Process
      - Atomic
      - Simple
      - Composite

OWL-S Model



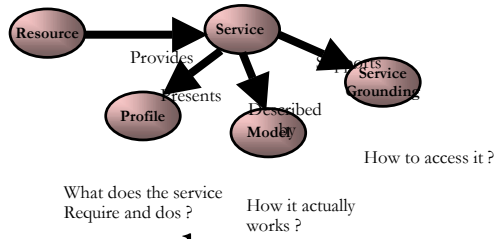
- **Process Control Ontology:** Enables the monitoring of the Service Execution
  - Mapping rules of Data from input state properties to output state properties
  - Execution state of the Atomic and Composite processes
- Candidate for a rule language for conditional processing(input/output) is SWRL from W3C, but the OWL-S itself does not mandate a specific rule based conditional processing mechanisms

OWL-S Groundings



- Grounding specifies on exactly how a specific services is accessed in the terms of :
  - Message Formats
  - Serialization
  - Transport and
  - Addressing
- This maps the abstract description of the service (Profile & model) to the concrete Services Instance.
  - Including the inputs and outputs of the atomic processes
- Depicts how the input, output messages of the atomic processes are concretely bound to a specific transmittable message formats.
- WSDL1.1 is utilised as concrete groundings to the abstract messages defined in the Service Model

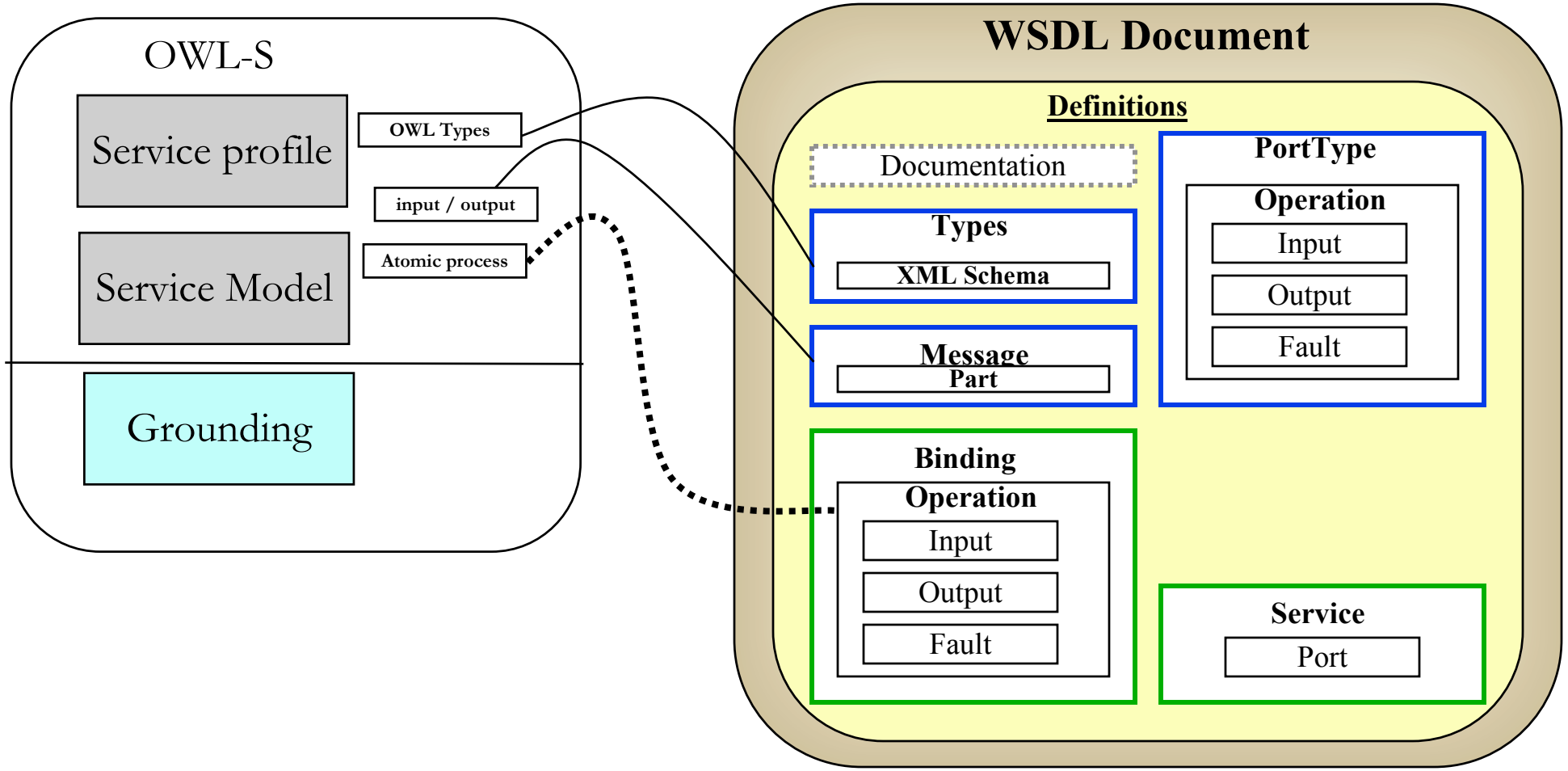
OWL-S Groundings

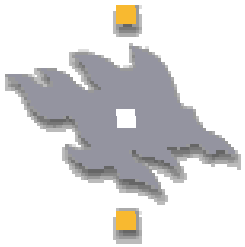


- The OWL's typing mechanism benefits the developer to choose instead of the XML Schema
- The OWL-S Can be grounded to work with WSDL and SOAP over Http as well.
- This leads to the Semantic Web Services

- **Bottom Line:** The Semantic Web Services can be considered as a REST complaint web architectures as it is based on URI, XML(RDF,RDFSchema, etc) and HTTP

OWL-S Grounding





Further reading

- Introduction to Semantic Web
  http://www.w3.org/2003/Talks/0506-Helsinki-IH/Overview.html
  http://www.w3.org/2003/Talks/1112-BeijingSW-IH/5.html
- **OWL-S: Semantic Markup for Web Services**
  http://www.daml.org/services/owl-s/1.0/owl-s.html
- OWL Introduction:
  http://www.w3.org/TR/2004/REC-owl-features-20040210/